



Heriot-Watt University
Research Gateway

Bridging the gap: university to professional qualifications

Citation for published version:

Thompson, P & Surgeoner, D 2014, 'Bridging the gap: university to professional qualifications', *Proceedings of the ICE - Management, Procurement and Law*, vol. 167, no. 4, pp. 189 –200.
<https://doi.org/10.1680/mpal.13.00034>

Digital Object Identifier (DOI):

[10.1680/mpal.13.00034](https://doi.org/10.1680/mpal.13.00034)

Link:

[Link to publication record in Heriot-Watt Research Portal](#)

Document Version:

Publisher's PDF, also known as Version of record

Published In:

Proceedings of the ICE - Management, Procurement and Law

General rights

Copyright for the publications made accessible via Heriot-Watt Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

Heriot-Watt University has made every reasonable effort to ensure that the content in Heriot-Watt Research Portal complies with UK legislation. If you believe that the public display of this file breaches copyright please contact open.access@hw.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

Bridging the gap: university to professional qualifications

Pauline Thompson BSc (Hons), PhD, FHEA
School of the Built Environment, Heriot-Watt University, Edinburgh, UK

Donna Surgeoner MEng, PhD, CEng, MICE
Institution of Civil Engineers Scotland, Glasgow UK

The jump from higher education to professional qualifications can be challenging. Engineering students do not necessarily leave university with the reflective and planning skills required for initial professional development (IPD). Many trainees do not understand IPD. These professional skills are not well covered in most UK universities. If this gap can be bridged then graduates may be more employable. This paper presents a case study where an IPD-style portfolio is used to assess the challenging breadth of the subject of sustainability with a large and diverse cohort of students. The details of the assessment, teaching methods and marking criteria are described and the challenges presented are discussed. Feedback was gathered from current students from the past 3 years, representatives of industry and the professional institutions. Ten companies were consulted including detailed interviews with recent graduates and senior engineers responsible for staff development and links to professional institutions. They were enthusiastic about the ideas presented in this work. This approach could be adopted widely throughout the university engineering curriculum. Professional institutions could consider how they might benefit from closer links with higher education. As professional institutions implement online systems for IPD they could consider ways to involve undergraduate students in the process.

1. Introduction

Civil engineering is a strongly vocational subject and most students who complete a degree aim to continue to become professionally qualified as incorporated or chartered engineers. Gaining an accredited BEng (Bachelor of Engineering) or MEng (Master of Engineering) degree (British) is thus the initial stage. The process of gaining individual professional accreditation usually then involves work experience and the compilation of a portfolio of evidence that is then followed by a final assessment. Most professional organisations use this style of approach to assess members for higher level professional grades of membership. The institutions that form part of the UK Engineering Council typically require their graduate members to undertake a few years of initial professional development (IPD) to acquire the professional experience required to be a chartered or incorporated engineer.

Is the process of moving from university to IPD as smooth as it could be? Do the professional institutions expect universities to help develop these professional skills for IPD or are they already teaching these skills sufficiently well? Anecdotal evidence presented below suggests there is room for improvement in the teaching of these skills. If university graduates are given support in these techniques at an early stage, will that give them a head start in IPD and make them more employable? In that case are universities teaching the analytical

and reflective portfolio skills required to become professionally qualified?

Heriot-Watt University, Scotland, runs a number of courses in civil and structural engineering. These courses are accredited by the Joint Board of Moderators (JBM) which assess and make recommendations on the accreditation and approval of relevant educational programmes that it will accept as meeting the requirement to register as a professional engineer with the Engineering Council. The JBM represents the Institution of Civil Engineers (ICE), the Institution of Structural Engineers (IStructE), the Chartered Institution of Highways and Transportation (CIHT), and the Institute of Highway Engineers (IHE). Ultimately the majority of the students will probably seek professional accreditation from either ICE or IStructE. The university aims to maintain strong links with these bodies and from an academic point of view it appears a healthy connection.

The lecturers at Heriot-Watt University strongly encourage all new students to join ICE, IStructE, CIHT and IHE. In their first year, over 95% of students join at least ICE. However, after this initial contact most of them seem to forget they are members and do not take much advantage of the opportunities on offer, although each year some students attend the ICE graduates and students events. These are social events, lectures and occasional site visits. Those that do attend really

appreciate them and tend to find they develop useful networks that can even lead to summer placements. Numbers attending fluctuate each year. Often it can be only two or three students attending an event but sometimes up to 30 Heriot-Watt students will attend. The university usually has student representatives on the committee, and attendance may depend on how these representatives publicise events. However, it is a small minority of the undergraduate student population, which is usually over 400 students. Student engagement with these organisations is, sadly, not thriving. Perhaps the school staff should also encourage them to participate in wider institutions such as the Institute of Environmental Management and Assessment or the Association of Project Managers and so on.

Ideally by the time students reach the beginning of their MEng year they should have considered the professional paths they need to take once they graduate so that they can plan their careers and collect any evidence required from work experience placements. However, for the last 2 years when a mixed final year MEng and MSc (Master of Science) class was asked how many of them had looked at the details of how to become chartered only one or two students out of a cohort of 60 to 80 students had even looked at the requirements! This is quite surprising and should be disappointing news for the engineering institutions.

This paper presents a case study of a course that shows one possible approach to linking university education to further professional development after graduation. The course uses a portfolio approach that is founded on the methods of IPD used by most professional engineering institutions. The portfolio approach not only links through to professional qualifications but also addresses many of the problems faced by teaching such a broad multidisciplinary course to a diverse student population. Herein the problems, successes and the potential value to the engineering professions are considered. The course has a strong focus on professional development skills. Students have to show understanding of their future professional responsibilities. By the end of the course they had all looked much more closely at the opportunities offered by these professional institutions. To evaluate its success detailed feedback was collected from current students, graduates and senior training and development staff in ten companies. Most of these senior staff also have roles within the professional institutions.

The case study course used is one on the subject of sustainability. The student population on the course is very diverse and the subject is one that is broadly familiar to most students already. A portfolio approach allows students to choose, within a broad framework, subjects that are more interesting and useful to them in their ongoing careers. They can choose how exactly they satisfy the 20 development

objectives set but need to set out a reflective case to show their learning supported by supplementary evidence to support their case. Formal teaching is only a small part of the course and instead they gain a lot of tutorial support with formative feedback, materials, case studies and projects that will clearly help them achieve the objectives.

A greater understanding of the professional qualifications paths should help focus and motivate students and ultimately improve their employability. Both the professional engineering institutions and universities could learn from sharing such ideas. The path to professional accreditation is perhaps not as easy as it could be. Student interaction with the professional organisations could certainly be improved. How can the professional bodies, industry and universities aim to improve the situation?

2. The use of portfolios in engineering education

Portfolios are a common mode of assessment in many subjects at university. In some cases e-portfolios are developed across a whole programme of study so that by the end of their degree students have a large body of evidence to show their progress and development. There is a wealth of literature showing how portfolios can be useful methods of assessment and can help trigger reflective learning. A review of this literature is beyond the scope of this paper but a good example is provided by Butler (2006). Practical examples of their applications and effectiveness are also abundant (Jisc, 2008). Although portfolios are not a new idea in science and engineering (Markes *et al.*, 2004; Payne *et al.*, 1993), they are still not commonly used (Kilgore *et al.*, 2013). A brief survey was done of the course descriptors available online from 20 UK universities to see how widely portfolios and reflection are currently used in civil engineering courses. Table 1 shows that only one university had a lot of work on portfolios and reflective skills. Another six had some mention of professional development planning but the majority made no mention of these skills. However, the online descriptor for the course described below at this university would also not indicate that the course used portfolios and reflection. In practice it is likely that more universities are covering this.

Some courses use the term portfolio in relation to a collection of design exercises and drawings as in an art portfolio. They can, however, be used in a much wider sense to include analysis and reflection in addition to a broad collection of evidence to prove achievement. As shown in many studies (e.g. reviewed by Butler (2006)) the use of portfolios has the potential to draw together the professional skills such as multidisciplinary communication together with the technical skills required later by graduate engineers. Portfolios are also generally used to assess professional qualifications as they can cover a diverse

Number of universities	Observations from online information
1	A focus on portfolios and reflective work over a number of courses. Three of these courses were design-based courses that required both individual and group reflective reports as well as a personal development plan. This style was replicated across three different years and also reflective logs were used in two further optional courses.
1	Use of portfolios for work placements but unclear if any reflection was involved.
5	Some form of personal development planning that included a minor component of professional skills or reflection.
13	Insufficient information but no courses with professional skills in the titles and no mention of professional skills in course descriptors.
Total 20	Universities surveyed: Abertay, Bath, Bristol, Cambridge, Cardiff, Dundee, Edinburgh, Glasgow, Imperial, Leeds, Loughborough, Manchester, Newcastle, Nottingham, Queens, Sheffield, Southampton, Surrey, Swansea, UCL.

Table 1. Survey of course information from 20 UK university civil engineering departments

range of skills and experience and so generating a portfolio is a professional skill in itself. This is one of the main reasons why they should perhaps be used earlier in academic education.

Some accrediting bodies (e.g. the Institution of Occupational Safety and Health (IOSH)) require that universities teach portfolio-type skills during their degree courses. It seems that this is not a general requirement for organisations linked to the Engineering Council. As Williams (2002) points out, although portfolios are recommended by the Accreditation Board for Engineering and Technology in the USA, there is little guidance on how best to use them. In the UK the JBM accredits university courses linked to the civil engineering disciplines. They expect universities to produce graduates with a high degree of ‘professionalism’ as identified in Annex F of their current guidelines (JBM, 2013). According to their guidance, professionalism should ‘contain elements which provide a good understanding of a broad range of inter-related social, economic and environmental issues’ (JBM, 2013: Annex F, p. 1). This should be embedded into the engineering education. However, nowhere does it require universities to teach portfolio-style skills or give guidance on the use of portfolios.

There are many aspects of portfolio use that can help students achieve the professionalism expected by the JBM, not least in developing the important skills of reflection and planning, which the authors feel are lacking from the experience of most undergraduate students. Reflection may be undertaken naturally by some students but for the majority it is an alien concept when an attempt is made to introduce it. The engineering curriculum usually leaves little room for reflection and frequently encourages the opposite behaviour ‘Students are rewarded for memorizing formulas and spitting back the lecture notes, rather than making connections, reflecting on

what their learning means, and deciding which areas in their learning need development.’ Williams (2002).

3. How do professional engineering institutions teach IPD?

To become professionally qualified, most Engineering Council-affiliated organisations have a period of IPD based on work experience followed by a professional review. As an example, the routes available for qualifications and career development through ICE will be examined (ICE, 2013a). With ICE there are two standard routes to complete the IPD stage; either a training agreement or self-managed training (career appraisal) with the assistance of a mentor. Many graduate trainees will get jobs with a company that has an approved training scheme. In this case, all support for the IPD process is provided by the company and a supervising civil engineer (SCE) is responsible for the monitoring of the graduate on the training scheme. Those not undertaking a training agreement must undertake a self-managed approach to complete their IPD. It is a very similar process but not formalised with their employer and so they usually have less employer support. ICE offers membership surgeries for individuals to help with career appraisal and is also starting to offer web broadcast sessions. The ICE graduates and students group also organises some of these events. Some training courses are offered by Thomas Telford Training, the training company owned by ICE. They run courses that can help with tackling the professional review but they do not appear to offer much assistance with the IPD stage (Thomas Telford Training, 2013).

There is written guidance available for trainees who wish to complete their IPD by career appraisal. ICE recommends they find themselves a mentor who is already a member and should know how the process works in detail. If they cannot find a

mentor themselves the regional offices will sometimes help find them someone appropriate. The main guidance on the career appraisal route is given in the document MGN11 (ICE, 2013b). One of the main requirements for IPD is to complete a set of development objectives (DOs) and a case to support them (ICE, 2013c). ICE does not publish good examples of submissions as there are so many potential routes to complete IPD but they do provide some guidance in the MGN11 document. In this they give examples of what work could be included but they do not provide much detail on how to address the objectives or a detailed guidance template for submission. They do provide a very useful explanation of the marking criteria as shown in Table 2. In particular they are looking to see that a trainee has progressed in the course of the IPD to a higher level of experience.

So for the majority of trainees, the support they get on how to do IPD is mostly derived from limited written guides by ICE and from their mentors or SCEs who are, hopefully, very familiar with the system. For the self-managed trainees, in particular, it could be hard to access a community of practice where they can share their ideas or learn from the best practice of others. It may also be hard to access personal feedback on their progress.

As it says in MGN11 (ICE, 2013b: p. 5) ‘Many trainees struggle to get to grips with the DOs[...] and fail to gain maximum benefit from their experiences gained in the 15 key areas.’ Senior representatives from industry (see section describing feedback below on success or failure) suggest that those that succeed tend to be self-starting and show good initiative, management and commitment. However, they think that most trainees find the IPD assessment process difficult to understand. It is a very different system to any they have usually experienced at university. It can be confusing, frustrating and difficult for them to be certain that they have achieved the objectives sufficiently well. They suggest that for engineers in particular, this more subjective and discursive means of assessment may be very unfamiliar. One industry trainer said the ICE process is probably the best structured and easy to follow but even that is difficult and a deterrent to some

achieving their full potential. Another, who was also an experienced assessor at the professional review stage, said ‘The whole process is very dependent on having good SCEs to provide the support. Often people fail their Professional Review because they have been given poor advice or had very little mentor support. If they fail at that stage it can be very hard to go back in their careers to make up the experience gaps they are missing.’

ICE certainly expects reflection as part of their DOs, and some industry representatives think that this lack of reflection in DOs and professional development reports contributes to failure at professional review. The DOs can initially not seem clear in their intent. Gap analysis and annual development action plans are also required for continuing professional development. Industry trainers suggest that graduates often struggle to understand what they should include in their plan. Most of the companies consulted here have set up networks and mentoring systems to exchange ideas on how their experience satisfies the objectives. It would be much harder to get through the process without this level of support.

Therefore, if it is at least covered in part in their university courses, they should have a head start when it comes to IPD. In addition, most graduate trainees do not realise the benefits of starting their IPD before they leave university and they may miss valuable opportunities to collect the evidence and records they need from previous work experience on summer placements.

4. A case study course on sustainability

4.1 Aims

The staff at Heriot-Watt University attempt to make the courses as professionally useful to the students as possible. One course that contains a broad range of professional skills is the course that focuses on sustainability in the MEng/MSc year. It is felt that this course can provide a valuable opportunity for the students to gain relevant experience that will ease the transition from university into the IPD stage of becoming professionally qualified, in particular as a chartered or

A	Appreciation	You must appreciate why the DO is important and why it is done.
K	Knowledge	You must have a basic understanding and knowledge of the DO and how it is achieved.
E	Experience	You must have achieved the DO, or part of it, working under supervision.
B	Ability	You must have achieved the DO several times in different situations, having the competence to assist others and to work without supervision.

Table 2. Institution of Civil Engineers’ ranking system for development objectives (DOs) (ICE, 2013c). A is the lowest rank and B the highest

incorporated engineer. The aim is to give students a better understanding of the requirements and methods for gaining professional qualifications before they leave university.

An IPD style process has been adopted for their assessment in this course. The hope is that by doing so, it will give the students an advantage when applying for graduate employment. It should also improve the linkage between the students and the professional organisations and raise students' awareness of their professional responsibilities.

4.2 A diverse cohort

This class has over 100 students on it each year and the range of ability and experience is broad. There are MEng students who are the highest achieving undergraduate students. These students are in their fifth year, are highly motivated but do not always have a lot of experience in industry. The class also includes MSc students who may have considerable previous work experience that can be useful to the course. Some of these are returning to education after a considerable gap. Others are new international students who may be struggling with a new country, university and ways of learning. This research-based technique is perhaps particularly challenging for them as they often expect a series of lectures with a knowledge and memory-based exam. In general, few of the students will have tried a portfolio approach to learning before.

There are also students in many locations. This course is run off campus for distance-learning students who get direct support from the university by email from staff and contact with other students on discussion boards. These students are often highly motivated and good at self-directed learning. They are frequently already in relevant employment and so usually have a wealth of experience to bring to the course. However, contact is not always frequent as they often lack spare time. With so many countries represented, the course materials need to be adaptable to suit any location and not be too focused on the UK or Europe.

Although this course was initially designed for civil engineers and the majority of students are engineers, the subject is relevant to many different programmes and as a result has been adopted for MSc courses in quantity surveying, construction project management, climate change, water resources and others.

With this diverse student population, finding a way of running a course that would suit everyone is a challenge. The main benefit of using a portfolio-based approach is that students can choose topics to suit their own needs, interests and experience. This diversity of experience is one of the main reasons why portfolios are so commonly used in IPD. The set of questions used in this course ensures that they cover a breadth of

material. Within this they may choose case studies and examples that are of particular interest to them. They can also work in groups and benefit from the diverse multidisciplinary peer support.

4.3 The subject area

Sustainability is a broad and open-ended topic with many different meanings. The area is subjective and not easily quantified but does allow students to express their own views and critical analysis. It is a popular subject area in the press and most students enter the class with a high degree of background knowledge. Although it would be desirable for students to have a more balanced objective viewpoint than they might get from the public media, it is inappropriate to teach them all the basics of the subject when they probably know much about it from the news. It would take some time to teach even the basics in an objective and analytical way, let alone to reach an appropriate level of critical detail. It is difficult to design a course for such a diverse group that will cover the breadth and depth required for a masters level course.

The challenges and potential solutions to teaching sustainability within the engineering curriculum have been well documented by Broadbent (2012). One case study cited by Broadbent was a project from the course discussed here where a modified version of the civil engineering environmental quality assessment (CEEQUAL) tool is used (more detail in the paper by Thompson (2010)). Broadbent identifies three challenges to teaching sustainability: (a) coping with complexity, (b) values-based decision making, and (c) interdisciplinary working. He then identifies nine principles with some practical solutions that can be applied to teaching undergraduate engineers. These principles include how to introduce the main building blocks of sustainability but also develop students' abilities to think critically and adopt a different mind-set to deal with sustainability. The aim is to develop professional values by considering real practical problems and the contributions of stakeholders and other disciplines. Putting learners outside their comfort zone may be a valuable lesson. Ideally this needs to be embedded throughout the curriculum and is not achievable by one course alone. However, a portfolio-style approach to a controversial subject such as sustainability at a fairly high level in the undergraduate curriculum has the potential to address many of the principles Broadbent raises directly.

4.4 Teaching method

As the course is taught in a similar way both on campus and by distance learning all materials are presented in detailed written form by means of the online virtual learning environment with supplementary short introductory lectures for on-campus students. These materials are essentially a broad introduction but all students need to look further afield to a wide range of

source materials and show they have done some analysis and discussion in relation to the course. The assessment strategy is well explained in the materials as proved by some excellent submissions from distance-learning students who do not have much other support.

Guest lecturers from industry are invited and there are also links to external events that students can attend and use as part of their studies for this course. They are also strongly encouraged to attend events run by the ICE graduates and students and the local membership development officer. Students are guided to use a lot of case studies; for example, they may also use work from other courses or work experience as appropriate. They are encouraged to summarise and reflect on all these in their portfolio.

Students are encouraged to complete two projects as part of the course. These are not directly assessed, but without them it would be hard to fulfil the learning outcomes required. The first project covers an environmental impact assessment (EIA) and planning application. Distance-learning students are expected to form groups and work together in writing a written objection to a planning application. In the classroom this is turned into a role play session. The class chooses an EIA to study between them and different groups are assigned the roles of developer, objector or planner. They must work together and developers and objectors present their cases in turn. The planners need to ensure that due process is taken, run the session, take public opinion into account (the rest of the class) and ultimately make the decision for or against the development. The second project uses a modified CEEQUAL tool as a means of analysis of one larger case study. This work has been explained previously by Thompson (2010). They need to show good analysis and, at the end, they need to reflect on their results to show they fully understand the process.

In addition to these activities, formative feedback is given to all students both individually and in groups on what makes a good portfolio and constitutes a depth of reflective learning. This is achieved by showing examples, peer comparison, practical tips, experiential learning etc. Over 50% of the teaching hours are spent in a tutorial-type approach dealing with these student needs as they arise.

4.5 Designing a portfolio approach

In order to make this course professionally useful the requirements for professional development within several institutions that are linked to the Engineering Council were investigated. These included ICE, the IStructE, the Institution of Chemical Engineers and the Safety and Reliability Society. Consideration was also given to other organisations that the students might apply to, such as the Royal Institution of Chartered Surveyors and the IOSH. Both these institutions also followed a very

similar approach but the final assessment method is aligned most closely to ICE and IStructE as the majority of the students will work in these fields.

Similar terminology to that used by the engineering institutions was chosen and therefore the portfolio requires the students to complete a set of DOs supported by a portfolio of supplementary evidence. The questions set for the DOs are obviously different to those required by the engineering institutions but they are in a similar open-ended style. Supplementary evidence can be created directly as part of the course or the students can bring in proof of any previous experience in work or other courses.

4.6 Development objectives

Table 3 lists the set of DOs that students need to prove they have satisfied. These were chosen over several years of iterations to cover the breadth of the subject and to trigger students to look into a wide range of subjects linked to sustainability, but at the same time allowing them the freedom to explore subjects of particular relevance to their chosen career path. This is the main item of work that will be marked. For each objective they need to show they understand the subject and discuss how they personally have met that target. If they can show progression in their experience during the course then that is excellent but as the course is only over 12 weeks they are not expected to show the progression that would be required for IPD.

In order to simplify the submissions and make them easier to follow a template is provided. This asks them to complete the following sections in answer to each DO (Table 4). A sample answer to one of the questions that gives many ideas as to what can be included is provided. However, with the diversity of students there is no typical 'example' answer and this sample is not necessarily the perfect solution.

4.7 Supplementary evidence

Supplementary evidence contains the files created by the students to support answers to the DOs. Anything appropriate will do, such as

- a reflective journal
- study plans that show personal development needs
- a CEEQUAL spreadsheet either individually or within a small group
- a planning objection/case on an environmental impact assessment proposal
- answers to some of the discussion questions from the main course text
- presentations made in class or to colleagues etc.
- minutes of meetings

Assessment/audit

- | | |
|---|--|
| 1 | Understanding of why it is important to measure sustainability and the associated problems and conflicts of different indicator sets and types |
| 2 | Knowledge of how sustainability in the built environment is measured locally to you |
| 3 | Critical interpretation of the results of simple 'best practice environmental option and footprint' analyses |
| 4 | Comparison of different life-cycle assessment tools |
| 5 | Comparison of the application of different international building assessment tools to a case study |

Professional

- | | |
|---|--|
| 6 | Awareness of the role of your profession (e.g. as a civil engineer) in the historical development of sustainability |
| 7 | Understanding of your professional responsibilities in relation to sustainability and the code of conduct of your profession |
| 8 | A detailed understanding of practical details and examples of how your profession could impact on sustainability issues |

Planning and project management

- | | |
|----|---|
| | Use or compare examples and evidence from environments local to where you live and work where possible to make it more useful for your future work |
| 9 | Understanding of how policies and procedures to manage sustainability are used in at least one organisation (e.g. your own company or British Land) |
| 10 | Aware of how environmental management systems can improve sustainability |
| 11 | Familiarity with planning systems, e.g. legislation, area plans, procedures, rights of appeal, control systems and responsibilities |
| 12 | Knowledge of contract systems and how they may influence sustainability |
| 13 | Understand the purpose and processes of strategic environmental assessments or sustainability appraisals and environmental impact assessments |
| 14 | Critical analysis of the details of at least one environmental impact statement |

CEEQUAL

- | | |
|----|---|
| 15 | Thorough understanding of the CEEQUAL analysis methods including: good use of the initial and potential scores, detailed evidence referenced and explained in spreadsheet, appropriate use of scoping out |
| 16 | A detailed understanding of a case study through a CEEQUAL analysis with critical reflections on how the case study could be more sustainable |
| 17 | Critical reflections on how the CEEQUAL tool could be improved beyond the current available options |

General understanding

- | | |
|----|---|
| 18 | An understanding of the general issues relating to sustainability with a focus on those that apply to your local area. You are expected to demonstrate a breadth of issues and your own critical evaluation |
| 19 | Detailed understanding of at least four case studies that illustrate a variety of issues and conflicts to do with sustainability |
| 20 | Aware of the responsibilities for sustainability in assessment, planning, project management, urban design etc. |

Table 3. List of development objectives for a course on sustainability

- records of conversations or emails
- work from other courses/employment
- feedback on your portfolio from other students/staff/colleagues/friends
- appendices of data
- pictures of sites you have visited that demonstrate details of sustainability
- any other item a particular student believes relevant.

4.8 An online system: a failure

In the first year that this portfolio system was developed the intention was to use an online system. The hope was to find a system that students could continue to use after they had left the university. It would form the basis for presenting at job interviews or starting their IPD. However, the facilities offered by the virtual learning environment (VLE) were not suitable.

1	Evidence. This is a written explanation that shows a detailed comprehension of all the points in the development objective. It will include information that answers the question but also demonstrates the student's ability. This can be backed up by supplementary evidence in additional files but it will be primarily the evidence here that is marked.
2	References to external sources. This is a list of any references cited in the evidence above. Here they need to show a wide range of source materials as the course materials alone are not sufficient to complete the objectives.
3	References to supplementary evidence. This is an indexed list of any additional evidence of their own that they have cited in the evidence above and submitted as part of their work.
4	Summary of achievement. This is an explanation of how the student met the objective. It should be a personal case to explain the processes they used to achieve the objective. It can justify why they chose that approach, explain any split of responsibilities in any group work. It should justify why they deserve the marks for the objective.
5	Reflection on progress. This section should build on the previous one and be a critical self-reflective evaluation of how the student thinks they achieved the objective. It should explain what is missing and where they would go next and possibly link to any personal development plans of their own.

Table 4. Template of answers required for each objective

A free site called Foliospaces was chosen as it closely suited the needs of the course. Essentially it was a mixture of a social networking site (similar to Facebook with contacts etc.) and a website with which students could create their own layout and links and store their files. The system was generally excellent with a good interface. Once students had developed their portfolios they only had to submit a link to their work to the university VLE to enable the tutors to mark it.

The system worked well, but it was a steep learning curve and a lot of explanation was required to enable students to master the technology. Many students really liked it but for some it was an additional hassle in an already challenging course. In addition, it could be time consuming to mark as students spread out the information and assessors had to cross-check many files. Finally, the site was not compatible with any plagiarism detection software such as Turnitin.

For these reasons it was decided to abandon the online system. This was fortunate as Foliospaces closed as a public site within the year and this would have caused considerable difficulties if the course had been dependent on its availability. This experience reinforced the notion that relying on online and public sites has inherent risks and so a simpler solution was adopted.

4.9 Current method

To reduce complexity the students now create a portfolio based on simple text files such as Word or pdf documents. A template is provided (Table 4) that ensures all submissions are similar and therefore easier to assess more fairly.

There are two reasons for the use of online submission through the university VLE. It is more efficient in collecting submissions from all students together at the same time giving distance-learning students equality with on-campus students. It

also allows submission through Turnitin as a plagiarism check. As this subject is so diverse, it could be hard to spot when a student's work is not their own. With this large class and a worldwide intake it is important to be able to detect plagiarism and this check is considered an essential part of the online submission.

4.10 Marking criteria

A requirement in the use of portfolios is to ensure that assessment is an efficient and fair process. Strivens (2006) presents some useful ideas on how to streamline assessment from a study of 23 case studies on portfolios in a variety of disciplines, which has helped inform the ideas adopted here.

Development objectives are all equally weighted, so if a student only submits a partially complete portfolio their marks will be reduced pro rata. Students are given guidance on marking criteria as in Table 5. It is not easy to assess such a subjective field without resorting to assessing the more superficial elements of their work but this scheme should reward deeper levels of understanding and critical reflection. Students are encouraged to think about the ICE levels of attainment (Table 2) when considering how well they have achieved each objective. Marking is based on a simplified version of these criteria as a rubric and written feedback comments are given individually to each student. This is a relatively efficient means of assessment and it has been found that with two independent but experienced markers it gives good agreement.

Formal formative feedback is given half way through the course. They are only guaranteed feedback if they submit at this point and this aims to get them to complete work sooner than they might otherwise do. Students are expected to submit two objectives and they are assessed according to the same criteria as the final portfolio. Distance-learning students receive detailed written feedback if they submit at this point.

For on-campus students the feedback is discussed in front of all students in class to save repetition. Some students do not submit work at this stage as it does not carry marks. However, all students can benefit from the verbal feedback in class and those that are lagging behind will hopefully see how much they need to catch up. All students can ask for further feedback during the rest of the course if time permits.

A good portfolio should meet the following criteria.

- Show a deep personal level of understanding of all topics.
- Match the wording of the core objectives you are trying to prove. Students will lose marks by only partly addressing the questions.
- Explain how you have achieved the core objectives. Many students fall into the trap of simply describing the objective or stating why it is important. The examiners will already know this. They need to know how you have developed your understanding of materials and what practical experience you have. Explain what you have done, what you have learnt and what you would do differently in future.
- Show practical use of the techniques investigated. Reading about a technique that others have used is never as good as trying to use it yourself.
- Show personal critical reflective thinking in evaluating all sources of information including your own observations. Make it very clear what you have personally undertaken. Examiners are not interested in hearing what your company or other people do, they only want to know what you have achieved. This is where the summary of achievement and reflection on progress are important.
- Be positive and not undersell yourself. For example, try to avoid statements such as 'I have limited/some experience' – you either have experience or not. If you have, justify it. If not, explain how you are going to address the gap.
- Show a wide range of source materials beyond the main course texts, with good referencing to specific details in longer documents.
- Involve a wide range of opinions from other students/staff/colleagues/friends.
- Show collective and well integrated group work with the ability to resolve conflict situations and produce results. Note that with group work you are all responsible so if there are errors in any section you will all be penalised. Do check yourself that all your collaborators have produced the same quality of work and that it is accurate.
- Demonstrate good presentation skills and clear, concise and fluent written analysis.
- Do not be too repetitive. In your explanation you can refer to other development objectives.
- Contain thorough, systematic and regular record keeping and planning of research methods to prioritise learning for the future.

4.11 Challenges

Some of the challenges faced in running this course are listed here.

- Most of these students are engineers and they are not so comfortable with this more discursive subject. They like maths and hard facts! They are not usually so accustomed to subjectivity, reasoning and argument (Williams, 2002). This is one reason why this course is so useful to them.
- As the subject is so open, it is hard for the students to gauge if they have done sufficient work as the subject has no limits.
- Many students leave the work until the last minute and then do not do as well as they could.
- It is difficult to explain exactly how to lay out the answers and how to address the questions.
- The technology of how to submit and how to manage the files causes problems even without the complexity of an online system.
- An efficient marking system is essential with such a large number of students.

The course lecturer believes that most of these problems have been addressed as explained in detail above. In summary, students receive detailed written guidance on the process, the method of submission, templates, guidance answers with transparent marking criteria from the outset. Formative feedback is detailed and readily available throughout the course to encourage successful progression. However, this is still a challenging course that places students well out of their comfort zones.

Marking is now shared between several staff in different campuses so not only do criteria need to be well defined and explained but training and moderation needs to be done across all assessors.

4.12 Success or failure?

It is difficult to evaluate quantitatively the success of this approach. During the last 3 years 232 students have studied the course. The submitted work is often of a very professional standard and the overall results are generally good. Some submissions were completed too quickly at the end of the semester and therefore were poor quality or incomplete.

Further detailed feedback was gained by talking to current students, graduates and employers over the last 3 years. Many students gave verbal feedback throughout and after the course. There is a strong alumni network with course graduates through LinkedIn. Feedback was requested from those who graduated in the last 3 years and for contacts with their training managers in a variety of companies. Ten companies were contacted in particular and very positive responses were received from all those contacted. More than ten recent graduates contributed more detailed feedback. Ten senior representatives from

industry were interviewed at length. These were generally people who were responsible for training and development within the company and all had helped many graduates complete their professional qualifications. Most of them had a role within a relevant professional institution too. A copy of this paper was sent to them and some of them spoke to the more recent graduates within their company about the course directly to see examples of their previous coursework. This was then followed up with a telephone conversation that added a lot of insight to this work. The intention is to continue this consultation by speaking to yet more people in industry and perhaps present this work at an event to stimulate further discussion and feedback. A summary of comments received so far is provided below.

4.12.1 Students' feedback

End of course survey results show satisfaction with this course is very similar to all other courses taken by this cohort of students. Initially the students do not like uncertainty and prefer a prescriptive approach. However, the majority appreciate the system by the end of the course and value it highly. Recent students were generally very enthusiastic about the course. There were numerous comments that aligned with the following 'This was the most useful course I did at university'; 'It was a challenge but I learnt more through this style of working than I have done before'; 'This was the most professionally relevant course we did'; 'We should have done it in earlier years too'. It was not all success, however, as a minority reported a lack of interest and excessive workloads 'It is very hard to know when you have done enough to succeed'.

4.12.2 Graduates' feedback

Most graduate responses were from people already on graduate training programmes and the feedback was entirely positive. Almost all thought the experience had helped them start IPD quickly and easily. Not many graduates have yet become professionally qualified and most are just starting IPD with many comments similar to this 'I have joined my graduate development programme and have already submitted 3 'key skill' reports. I definitely think it has helped with my reports and development. I have recently had to complete a report on Environmental Awareness and everything we did on the course was relevant to the report. Some of the other students that did your course are also finding this useful. We also have to have a good understanding of the different aspects to take into account for a project. I completed my first quarterly report recently and the style is very helpful. We have to demonstrate how we developed our knowledge, understanding and skills. I feel the set up and what we had to demonstrate at the portfolio definitely helped with understanding what to do.'

The only ones who found it more of a struggle said they really regretted that they had not put quite enough effort into the course as they did not realise just how important it was at the

time 'reflection is still quite hard though! ...should have put more effort into the reflective log we did with you – didn't realise quite how important that was till now'.

However, at least one graduate has become chartered very fast 'For some parts of the evidence I needed to produce to become chartered [...] my line manager was happy to use some of the evidence I collected for this course as part of the evidence that I had achieved the IPD objectives.'

4.12.3 Senior engineers' feedback

All of the more senior staff interviewed agreed that linkage between universities, institutions and industry is not sufficiently good and that opportunities are being missed. Some staff felt that some institutions should be more involved in the learning and teaching right through from students to industry. They felt that some institutions were only acting as examiners and could get more involved. 'Most of our graduate trainees arrive with us thinking they already know everything and it is a steep learning curve working out the route to chartership.' A common complaint is that graduates do not have sufficient transferrable skills such as communication. They also express frustration that some new graduates are too focused on the detailed civil engineering part and do not see the bigger picture or appreciate how broad and multidisciplinary the role is.

Employers who have seen the work seem impressed by the approach used in this course both in terms of the practice for professional qualifications but also in addressing some of the softer transferrable skills required and making students consider the wider impacts of their work. They would really like to see more students coming to them with a greater understanding of the professional development they need to do following their degree. They feel greater discussion linking industry, institutions and universities is sorely needed.

One student said 'I took my portfolio and Development Objectives to my job interviews. The panel were much more interested in this than my dissertation!' An employer said 'I am always impressed when people would come to interview with a good record of their achievements and have started compiling evidence for their professional qualifications. A portfolio like this would be very interesting to us as it would show the applicant has the potential to reach CEng faster.' Another thought that there will be a rapid expansion in the construction industry soon 'We need to employ people that we can promote to management positions fast. To do that they have to become Chartered quickly and if they come to us with some initial progress on their IPD then we know they have a head start.... I do think that your proposal goes a long way to preparing students for work and must be developed to help address the looming skills crisis. What I'm not entirely convinced about is

industry's readiness to fast track the most competent into positions of real responsibility.'

5. Conclusion

This study has shown a case study in which portfolios have been used for a course on sustainability in civil engineering. One of the main aims was to improve the professional portfolio skills of graduates so perhaps in future they will find it a quicker and smoother process to become chartered. Therefore the style and design of the assessment closely mirrors that required for IPD. As the course design is in its infancy, very few graduates have gained professional qualifications. It is therefore difficult to tell at this stage whether the approach really succeeds. However, initial feedback suggests the methods seem to work well. From the instructor's point of view it solves a lot of the challenges of teaching this challenging subject. Detailed feedback from those who have taken the course is generally good especially after they have reached employment. Of particular note has been the enthusiasm shown by senior industry staff responsible for training and development within their companies. They contributed many further ideas to the study but overall were unanimously positive that this approach should work well in its ambitions.

The future plan is to continue to run this course in a similar format with fine tuning to the delivery and assessment. It is hoped that improvements will be available to improve plagiarism detection, and perhaps in future online portfolios can be restored if technology improves. It will be particularly interesting to keep track of recent graduates to see how their careers progress and if this course has made any difference.

6. Thoughts for the future

In setting up this course a lot of knowledge has been derived from the professional institutions, but it is felt there is still scope for improvements both within universities and the professional institutions as to how portfolios and professional skills are assessed.

There may be ways the professional institutions can learn from educational practice in universities. These institutions need to consider how they can improve their teaching methods so that more people understand and benefit from the IPD process. This could be by introducing portfolios at an earlier stage in university education and possibly giving more training in the IPD approach. Perhaps the institutions need to be more involved with students at several stages in their studies. Currently, only ICE visits at the beginning and ICE and CIHT at the end of their studies. Further input would help reinforce the value of professional qualifications.

ICE is currently considering developing an online system for IPD. This will probably only be available to trainees who

register on the IPD process. Trainees will no doubt then get on-line support by means of feedback from their mentor. In future it would be good if the system was open to all student members even if they did not get the feedback opportunities from professional engineers. This could help undergraduate students work out where they are heading so that they can plan more effectively for the future. In future the professional institutions could consider using a publicly accessible online system so that universities could use the same technology for their courses too. Then students and trainees could use their portfolio in a transferrable way as they left university. Of course a public system would be costly and harder to implement and given the failure of the online trial that was attempted for this course perhaps this is a risky option at this stage.

Plagiarism is a problem at universities. It is understood that ICE uses plagiarism detection for the professional review written exercise but it should also use it for the development objective sections of the IPD process.

Within universities there may be plenty of scope for adopting these reflective portfolio methods across many courses. Last year's students suggested it should be a skill developed throughout a degree programme. It may not work so well for earlier years but would lead them into good habits more gently as they progress to higher years. In particular, it could also be used as a more structured approach to doing research projects. For each course a different set of DOs would probably be required but there may be some projects for which the ICE DOs could be applied directly.

Are universities consistently emphasising the importance of professional qualifications? It is worrying that students have not thought about them until their final year. Is a good example being set? Not many academic staff gain professional qualifications themselves. This is a requirement for accreditation of courses by the JBM but many academics do not see it adding much value in their careers so there is little incentive to do it.

Another option that could add to the experience base for all students would be to make more use of mentoring. The internal mentoring system between staff and students at Heriot-Watt could support this. The piloting of a student-to-student mentoring system involving students from different years within the course is also being considered. However, for professional development, mentoring from industry would be most useful. This is currently available at this university through the careers service. At present there are insufficient volunteers in the civil engineering industry to meet the number of students wanting an external mentor, but hopefully this will improve significantly soon. This invaluable source of support could be used to help students find ways to gain further

evidence of their experience to support their university portfolios. However, this mentoring system would be better if run on a wider scale. There is certainly interest in industry for such mentoring schemes and it is a valuable skill for all staff to participate in. It would seem an ideal opportunity to raise the profile of the institutions with students if they ran some kind of online networking system to help arrange mentors?

In summary, the links between institutions, industry and academia need to be strengthened.

Acknowledgements

The authors would like to thank all the industry representatives who contributed valuable feedback to this work. They represented the following companies: Arup, Grontmij, Jacobs, Morrison Construction/Galliford Try, Mott MacDonald, Petrofac, Scottish Water, Technip, Transport Scotland, URS, Wood Group. The authors are particularly grateful to Neil Abraham, David Bain, Stephen Davies, James Ferguson, Jenny Garbe, David Glen, Kirsten Goll, Jon Hodgins, John MacLennan, Heather Plummer, David Robertson, Sandy Ross, David Shelbourn, Michael Spencer, David Taylor, Stephen Thomson, Michael Tisone, Stuart Turnbull, Lynsey Tweedlie and Liz Urquhart.

REFERENCES

- Broadbent O (2012) *Embedding Sustainability – A Practical Guide*. Think Up, London, UK. See http://www.thinkup.org/assets/img/projects/Embedding_Sustainability_in_the_Undergraduate_Civil_Engineering_Courses.pdf (accessed 01/07/2013).
- Butler P (2006) *A Review of the Literature on Portfolios and Electronic Portfolios*. eCDF ePortfolio Project, October 2006. University of Guelph, Guelph, Canada. See <https://www.uoguelph.ca/tss/projects/ePresources/Review%20of%20literature%20on%20portfolios%20and%20ePortfolios.pdf> (accessed 01/01/2014).
- ICE (Institution of Civil Engineers) (2013a) *Qualifications and Career Development*. ICE, London, UK. See <http://www.ice.org.uk/qualification-careers> (accessed 07/2013).
- ICE (2013b) *Membership Guidance Note MGN 11 – Career Appraisal*. ICE, London, UK. See <http://www.ice.org.uk/mgn11> (accessed 01/07/2013).
- ICE (2013c) *ICE 3005A – Development Objectives*. ICE, London, UK. See <http://www.ice.org.uk/ice3005a> (accessed 01/07/2013).
- JBM (Joint Board of Moderators) (2013) *Guidelines for Education Providers*. Joint Board of Moderators, London, UK. See <http://www.jbm.org.uk/> (accessed 01/07/2013).
- Jisc (2008) *Effective Practice with e-Portfolios*. Jisc, Bristol, UK. See <http://www.jisc.ac.uk/media/documents/publications/effectivepracticeeportfolios.pdf> (accessed 01/07/2013).
- Kilgore D, Sattler B and Turns J (2013) From fragmentation to continuity: engineering students making sense of experience through the development of a professional portfolio. *Studies in Higher Education* **38**(6): 807–826.
- Markes I, Maddocks A, Bamforth S and Crawford A (2004) UK SPEC and the RAPID Progress File: a tool for academic, personal and professional development in engineering. *International Conference on Engineering Education*. International Network for Engineering Education and Research, Potomac, MD, USA. See [http://www.ineer.org/Events/ICEE2004/Proceedings/Papers/269_IM_ICEE_2004paperDOCfile_V2_\(1\).pdf](http://www.ineer.org/Events/ICEE2004/Proceedings/Papers/269_IM_ICEE_2004paperDOCfile_V2_(1).pdf) (accessed 01/07/2013).
- Payne RN, Bramhall MD, Lawson JS, Robinson I and Short C (1993) Portfolio assessment in practice in engineering. *International Journal of Technology and Design Education* **3**(3): 37–42.
- Strivens J (2006) *Efficient Assessment of Portfolios*. Centre for Recording Achievement, Institute of Educational Technology, The Open University, Milton Keynes, UK. See [http://www.open.ac.uk/opencetl/files/opencetl/file/ecms/web-content/Strivens-\(2006\)-Efficient-assessment-of-portfolios.pdf](http://www.open.ac.uk/opencetl/files/opencetl/file/ecms/web-content/Strivens-(2006)-Efficient-assessment-of-portfolios.pdf) (accessed 01/07/2013).
- Thomas Telford Training (2013) *ICE Membership Courses*. ICE, London, UK. See <http://www.tttrain.co.uk/Courses/Index.aspx?CourseCategoryID=ICE%20Membership> (accessed 01/07/2013).
- Thompson P (2010) Using CEEQUAL to teach sustainability in civil engineering. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **163**(4): 209–217.
- Williams J (2002) The engineering portfolio: communication, reflection, and student learning outcomes assessment. *International Journal of Engineering Education* **18**(2): 199–207.

WHAT DO YOU THINK?

To discuss this paper, please email up to 500 words to the editor at journals@ice.org.uk. Your contribution will be forwarded to the author(s) for a reply and, if considered appropriate by the editorial panel, will be published as discussion in a future issue of the journal.

Proceedings journals rely entirely on contributions sent in by civil engineering professionals, academics and students. Papers should be 2000–5000 words long (briefing papers should be 1000–2000 words long), with adequate illustrations and references. You can submit your paper online via www.icevirtuallibrary.com/content/journals, where you will also find detailed author guidelines.